photometer. He has also paid fruitful attention to a number of oceanographic problems. His first papers were on the influence of plankton on the quantities of oxygen and carbonic acid dissolved in sea water. His researches in the field of low pressure phenomena in gases are better known to physicists than to oceanographers.

In addition to his activities already mentioned, Knudsen has since 1902 rendered invaluable service as a consultant in hydrographical investigations for the Danish Government and the International Council for the Exploration of the Sea.

The members of the committee that nominated Professor Knudsen for the Agassiz Medal are happy that the academy approved its recommendation. Professor Knudsen richly deserves the honor conferred upon him.

T. WAYLAND VAUGHAN

WASHINGTON, D. C.

PRESENTATION OF THE MARY CLARK THOMPSON MEDAL TO AMADEUS WILLIAM GRABAU

THE Committee on the Mary Clark Thompson Fund, meeting in 1936, decided unanimously to award the medal provided for in this fund "for most important services to geology and paleontology" to Amadeus William Grabau, professor of paleontology in the National University of China and chief paleontologist to the Chinese Geological Survey. Among the recipients of this medal since 1924, chiefly paleontologists, are C. D. Walcott, E. de Margerie, J. M. Clarke, J. Perrin Smith, W. B. Scott, E. O. Ulrich, David White, F. A. Bather and, in 1934, Charles Schuchert.

The committee noted the distinguished services of Professor Grabau in general and stratigraphic geology, in the science of non-metallic mineral deposits and particularly in paleontology. His paleontological researches cover the Paleozoic of New York and during the last seventeen years the paleontology of China. The results of this work are contained in a splendid series of monographs on Chinese Paleozoic and also Mesozoic fossils, the last volume of which was published like the rest by the Academia Sinica, in Peking.

Professor Grabau was born in Wisconsin in 1870. He studied first in the Massachusetts Institute of Technology, where he served as instructor from 1892 to 1897. After obtaining his Sc.D. at Harvard in 1900 he served as adjunct professor at Columbia University, 1902–1905, then as professor from 1905 to 1919. In 1920 he was appointed to the two important positions in China mentioned in the first paragraph of this address, and he has remained there for the last seventeen years working unceasingly and most successfully on the paleontology and geology of China. His contributions are fundamental and exhaustive. And this in spite of severe physical handicaps during later years which would have discouraged any man with less courage and energy. Among his characteristics are an indomitable nature; a faculty of inspiring others with his enthusiasm; an ability to plan and carry out the work to which he has devoted his life.

The work of Professor Grabau is incorporated in a long series of publications. In 1910 he published in collaboration with another distinguished paleontologist, Professor H. W. Shimer, of the Massachusetts Institute of Technology, a widely used book on "North American Index Fossils." Later came "Succession of Faunas in the Middle Devonian in U.S.A."; the "Hamilton Fauna of Michigan"; "The Phylogeny of Invertebrates, Chiefly Gastropods"; "Principles of Stratigraphy" (second edition in 1921); "Textbook of Geology," 2 volumes, 1921; "Nonmetallic Deposits," 2 volumes, 1922; "Ordovician Fossils of North China," 1921; "Stratigraphy of China," 1925; and last but not least the succession of volumes referred to above and published by the Academia Sinica under the general heading, "Paleontologia Sinica." Besides these there are a great number of shorter papers. Enough of an accomplishment, one might say; enough to fill a long life.

I feel sure you will agree with me that in presenting this medal we are paying a just tribute to a most distinguished paleontologist and geologist who has brought honor to American geology to the four corners of the earth.

We regret deeply that Professor Grabau is unable to be here in person, but rejoice that we may entrust the medal to Mrs. Grabau, who is here with us to-night and who will transmit the token to Professor Grabau with our admiring regards.

WALDEMAR LINDGREN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING OF THE NATIONAL ACADEMY OF SCIENCES

A catalogue of neurohumors: G. H. PARKER. Neurohumors are hormones produced by the secretory portions of the nervous system or by glands immediately associated with this system and serving as means of activating other parts of the nervous system and its effectors, such as muscles, glands, chromatophores and the like. Neurohumors are well illustrated by adrenalin, a secretion of the adrenal gland, and by intermedin, a product of the

intermediate lobe of the pituitary gland. Both these neurohumors act on the vertebrate melanophores of the integument, adrenalin causing these color cells to concentrate their pigment, intermedin to disperse it. In fishes such as the catfish the melanophore pigment disperses not only to intermedin, but also to a neurohumor from the melanophore nerve terminals. This pigment probably concentrates to a blood-borne neurohumor like adrenalin, perhaps adrenalin itself, and to a neurohumor from a second series of nerve terminals. Thus four sets of neurohumors are concerned with the activities of the melanophores in the catfish, two dispersing and two concentrating. Those from obvious glands are soluble in water and carried by the blood. Hence they have been termed hydrohumors. Those from the nerve terminals are insoluble in water but soluble in ether or oil, hence lipohumors. Hydrohumors are general in action, lipohumors local in action. Beside the four neurohumors acting on melanophores, there is in some fishes like the killifish an additional and independent set of neurohumors acting on the yellow cells or xanthophores. Thus in the chromatophore system there must be many kinds of neurohumors. When these many neurohumors are added to those such as acetylcholin, sympathin, and so forth, from other parts of the nervous system, it is seen that neurohumors, contrary to the older view, are an extremely diverse and numerous set of substance.

Pinocytosis—Drinking by cells: WARREN H. LEWIS. Normal macrophages and many malignant cells when cultivated outside the body thrust out thin active wavy ruffle pseudopodia which entrap and fuse around portions of the surrounding fluid and enclose them as globules within the cell. The globules move centrally, the contents are digested and the fluid then diffuses out of the cell. In the course of a few hours a cell may drink several times its volume of fluid. In this manner cells take in complex substances in solution such as proteins which can not diffuse into them. The macrophages, which come from the large mononuclear white blood cells, are scattered in the tissue spaces throughout the body in enormous numbers. We have been familiar for many years with the rôle they play as phagocytes; they ingest and digest dead cells and other debris such as occur in black and blue spots. As pinocytes (drinking cells) they probably play a still more important rôle, namely, the maintenance of the body fluids in proper condition, for there is good evidence that within the body they are continually drinking in, digesting and thus modifying the tissue fluids which bathe most of the cells of the body.

Hereditary vulnerability to dietary defects in the development of bone: G. L. STREETER, E. A. PARK and DEBORAH JACKSON. At the end of the first month, when their bone development is most active, young rats can be weaned and placed on any desired diet. After a sufficient period of test diet, if one wishes to study the effect of that diet on growth of bone, one can make x-ray films of a selected bone area and record the progress of its development. The animals in our experiments, after being subjected for three weeks to a rachitic diet and then x-rayed, were returned to a normal diet and reared, uninjured by the experience. Four months later they were bred. The breeders were chosen on the basis of the x-ray record of their sensitivity to the diet. Following fourteen generations of such selection and inbreeding, two strains of rats have been developed which in all appearances are alike, save in the one character that one of them reacts more severely to a rachitic diet (vitamin-D-free, high calcium and low phosphate) than the other strain. These experiments reveal the plastic nature of the growth line (epiphysis) of bones and its sensitivity to disturbances in the chemical composition of the body fluids. They also support those investigators who claim that heredity is a definite etiological factor in abnormal bone development, of the type seen in rickets. From such experiments we can thus understand why under equally unfavorable conditions the children in some families acquire rickets, while others do not.

The distribution of gene frequencies in populations: SEWALL WRIGHT. (To be printed in SCIENCE.)

Immunity and reinfection in experimental poliomyelitis: SIMON FLEXNER. As experience has grown, it has become apparent that the two immune states in poliomyelitis (infantile paralysis), one based on recovery from an attack of the disease and the other symptomless reaction to virus injections (vaccination), are not identical. They do agree in that under both sets of conditions antibodies usually appear in the blood; they differ in that symptomless immunization is less protective against reinoculation of the virus than is the state of resistance which develops upon a symptomatic infection. That reinfection called second attack does occur is established for children and even for monkeys, although this phenomenon has been given little attention. The study to be reported is based on a considerable number of monkeys which have recovered from attacks of poliomyelitis experimentally induced. The virus employed for reinoculation was always instilled into the nose. Several kinds of virus, derived from epidemics of infantile paralysis occurring in the years 1909 to 1935, were employed for these experiments. Attention was paid to the occurrence of distinct immunological strains among these specimens of virus used for reinfection. Certain conclusions have been reached as a result of the studies which may be stated briefly as follows: Monkeys which have recovered from an attack of experimental poliomyelitis are subject to reinfection by the nasal route. Second attacks of the disease result from inoculation with the specimen of virus used to produce the first attack and with specimens of different origin. Reinfection takes place in monkeys which have recovered from mild and from severe attacks and in convalescent animals which have been subjected to hyperimmunization. The two-year quiet period proposed by Still to separate relapses from second attacks, judging from the monkey, is probably excessive. Until greater attention is given the reinfections of varying intensities in man, conclusions on this point must be wholly tentative.

Experimental menstruation: GEORGE W. CORNER (introduced by George H. Whipple). It has long been known that menstruation is dependent upon the ovaries. Since the identification of the two ovarian hormones, oestrin

(the "female sex hormone") and progestin (the corpus luteum hormone) a number of observations have been made which hint that the menstrual phenomena may ultimately be explained in terms of the action of these two hormones upon the uterus. In a castrate monkey, for example, the cessation of a course of oestrin injections causes menstruation-like bleeding (E. Allen), and menstruation has therefore been tentatively explained as due to cyclic fluctuations in oestrin level. Oestrin (in moderate, presumably physiological dosage) does not, however, inhibit, in intact monkeys, an expected menstrual flow (Corner), but progestin does inhibit menstruation (Corner) and also oestrin-deprivation bleeding (Engle, Smith and Shelesnyak; Hisaw). Moreover, measurements of the oestrin content of the blood in women have not certainly revealed a correlation between menstrual bleeding and variations of the oestrin level (Fluhmann). In the experiments now to be reported, castrate monkeys receiving injections of oestrin (100 or 125 international units) were also given, after a suitable control period, one mg pure progesterone daily for 10 days. Menstruation-like bleeding occurred four or five days after cessation of the progesterone, in spite of the continued oestrin treatment. Elevation of the oestrin dosage to 500 international units did not completely prevent bleeding after progesterone under these conditions. Quantitative experiments designed to explain the mechanism of this effect are now in progress. The experiments point to a possible explanation of the menstrual bleeding of the uterus (in ovulatory cycles, at least) as the result of alternating presence and absence of the corpus luteum hormone, without the necessity of postulating cyclic variations in oestrin level.

Body fat as a factor in heat production: FRANCIS G. BENEDICT and ROBERT C. LEE. It has been commonly believed that body fat is metabolically inert. Experiments on geese and mice at the Nutrition Laboratory, however, indicate that body fat plays a rôle in metabolism. The geese were adults and the differences in size represented, chiefly, differences in fat content, for little protein is added to the body when adult geese are fattened. The total heat production was greater the larger the goose and in nearly direct proportion to the increase in weight. The heat production per unit of weight was essentially the same with geese weighing from 4.5 to 7.5 kg, although it has usually been found that the larger the animal species the lower is the heat production per unit of weight. Comparisons were also made of the basal metabolism and the body composition of the 20-gm albino mouse, the 60-gm fat mouse and the 8-gm dwarf mouse. Per unit of surface area the metabolism of the fat mouse is nearly twice as great as that of the dwarf mouse and 15 per cent. greater than that of the albino. Although the fat mouse weighs three times as much and has twelve times as much body fat as the albino, both have nearly the same amounts of body nitrogen. Yet the total daily heat production and the heat production per gram of dry protein of the fat mouse is more than double that of the albino. That body fat increases the energy production is, therefore, undeniable. The obese must pay in calories for their fat loads.

Sympatho-mimetic influence of deuterium oxide[1]*:* HENRY GRAY BARBOUR (introduced by Yandell Henderson). The mammalian body is over two thirds water. Substitution of one half the water by the recently discovered heavy water (deuterium oxide) is incompatible with life. When, however, the body water is but one fifth saturated with heavy water a mouse survives, but lives at a faster rate; that is, metabolism is increased by some 20 per cent. or more, usually with some elevation in body temperature. These effects appear due to excessive stimulation of sympathetic nerve mechanisms (sympatho-mimetic action). More definitely, sympathetic stimulation by heavy water can be shown in the pilomotor (hair raising) and exophthalmic (pop-eye) mechanisms of mice. When one fifth saturated they not only become rough-furred and pop-eyed, but these effects can be abolished almost immediately by ergotoxine, an alkaloid specifically depressant to the sympathetic system. Fish resort to protective camouflage in light surroundings by turning themselves pale. This is done by the sympatho-mimetic effect of light acting through the eye to cause contraction of the dark pigment in the melanophores. Heavy water also contracts melanophores but not after ergotoxine. One can mimic all the above effects, on metabolism, temperature, fur, eyes and skin, by injecting epinephrine, one of the sympatho-mimetic emergency hormones, secreted by the adrenal glands to prepare the body for fight or flight. Heavy water reinforces the natural substance epinephrine. Possibly it exhibits its sympatho-mimetic influence by delaying the disappearance of the natural hormone from the body. The details are described elsewhere in respective co-authorship with Drs. Bogdanovitch and Herrmann and Misses Trace and Rice.

The effects of alcohol as influenced by blood sugar: HOWARD W. HAGGARD and LEON A. GREENBERG. (To be printed in SCIENCE.)

Embryonic induction in regenerating tissue: OSCAR E. SCHOTTÉ (introduced by Ross G. Harrison). Previous experiments presented at last year's meeting of the Zoologists at Atlantic City have shown that the mesenchyme of regenerating extremities of Amphibia is totipotent, since typical lenses have been obtained by transplantation of this tissue on eyes of adults previously deprived of their lenses. In order to further test the potencies of this mesenchyme, embryonic eye-cups of *Rana pipiens* (stage 28 or 29, Harrison) have been transplanted below the skin of regenerating tails of large tadpoles. These eye-cups not only induced the regenerating mesenchyme to differentiate into typical lenses, but also induced in every case a complete redifferentiation of the surrounding cells. The loose mesenchyme now becomes a dense mass of cells, numerous mitotic figures occur, and eventually the differentiation of organs not connected with eyes can be observed: olfactory capsules, ear vesicles and even mouth cavities appear in the midst of the tadpole tail. This unusual effect of typical embryonic inductors is tentatively explained by the spreading of correlated morphogenetic fields, a process quite different from that

[1] These investigations are supported by the research funds of the Yale University School of Medicine.

which occurs in normal development. In the embryo, a spatially closed system, the differentiation of the available materials blocks any further action of "organizers," for which only a limited amount of cell material is available. In this new process of induction in regenerates, on the contrary, far more generalized effects are obtained because proliferation secures a continuous supply of fresh, undifferentiated cells. After the cells in the midst of which the inductor has been implanted become differentiated into new organs, they in turn serve as inductors to the proliferating mesenchyme. Other facts have shown that morphogenetic fields continue to be active throughout life, and now the above experiments suggest that proliferating mesenchyme embodies properties of indifferentiation similar to those of the embryonic ectoderm of amphibians before gastrulation.

On the evaporation from the oceans: H. U. SVERDRUP (introduced by T. Wayland Vaughan). The water which evaporates from the oceans is equal to the amount of water vapor which is transported upwards from the sea surface by processes of molecular diffusion and by eddy conductivity. Turbulence research in laboratories has led to a semi-theoretical expression for the eddy conductivity of air flowing over a rough surface and to a simple law for the variation of velocity with increasing distance from the surface. Observations of wind velocity at various levels have shown that this law is qualitatively valid over the sea. The same law is valid when dealing with the humidity, except that then it is necessary to assume the existence of a thin layer near the surface through which transport of water vapor takes place by diffusion. The thickness of this layer was found to be inversely proportional to the wind velocity, decreasing from 0.75 cm at a wind velocity of 1 m per second to 0.075 cm at a wind velocity of 10 m per second. Supposing that above this layer the eddy conductivity has the value which follows from the laboratory experiments and that the numerical constants which have been determined by such experiments can be applied, the amount of water vapor which is transported upwards can be computed if the wind velocity, temperature and humidity are known at one level and if the surface temperature of the water has been observed. From the Atlantic Ocean average meteorological data and corresponding average values of the evaporation are available. The values of the evaporation which have been computed by means of the meteorological data, making use of the above-mentioned assumptions, agree very well with the observed values. It seems, therefore, possible that by means of this procedure the evaporation can be computed under any given meteorological conditions.

How deep do ocean currents flow: COLUMBUS ISELIN (introduced by Henry B. Bigelow). At the present time physical oceanographers are in sharp disagreement as to what depths should be assigned to the lower boundaries of the major ocean currents. The older point of view is that while velocity decreases gradually with depth, some flow parallels the surface movements down to at least 2,000 meters. The newer conflicting theory is that the layer having a minimum oxygen content is also nearly motionless, and for all practical purposes marks the lower limit of the surface currents. Since the axis of the layer having the least oxygen is found at depths of only 300 to 400 meters near the equator and nowhere is deeper than 900 meters, all attempts to calculate the volume or velocity of ocean currents give very different results, depending on which of the above theories the particular investigator favors. Unfortunately as yet little conclusive evidence is available to support either view. The significance of this controversy in the case of the Gulf Stream and the Northern Equatorial Current is described and several arguments advanced that indicate that the older idea of relatively deep ocean currents should by no means be thrown into the discard.

Plankton and radiolarian ooze in Paleozoic formations of New York: RUDOLF RUEDEMANN. The plankton consists principally of the graptolites and associated organisms that were connected with the Sargasso-seas of the Atlantic Ocean and were carried into the great Appalachian geosyncline that extended from Newfoundland to beyond Alabama, at such times when it was open to the ocean currents. The associated organisms are principally small sponges, very primitive brachiopods and crustaceans. Other planktonic organisms of later Ordovician, Silurian and Devonian periods will also be shown. The Radiolarian faunas have been discovered in thick chert beds, associated with the graptolite shales. Nearly all the chert beds contain radiolarians and nothing else save occasional sponge spicules and graptolites. Some beds are entirely composed of radiolarians and these are compared to the "radiolarite" of the Alps and East Indies, which is considered as fossilized "radiolarian ooze." The fauna consists almost entirely of genera still living to-day and some of them are not found above 12,000 feet in the present oceans. The conclusion is therefore reached that the radiolarian chert represents radiolarian ooze formed at a depth corresponding to that at which the ooze is formed to-day and that the bottom of the Appalachian geosyncline sank at times to such abyssal depths.

Random Waring's theorems: NORBERT WIENER and NORMAN LEVINSON. It is well known and has been proved by Hilbert that every number is the sum of at most a finite number of kth powers of integers. There is reason to suspect that the vital part of this theorem concerns not the number-theoretic nature of the terms n^k but their manner of growth. The present paper is devoted to the proof that if λ_n is chosen at random between zero and n^k, in almost every case almost every integer can be represented as the sum of $k+1$ such numbers, and in almost every case there will exist a set of integers of density greater than zero which need $k+1$ such numbers for their representation. Similar theorems are proved for random selections not among all integers of a given range but among all integers of certain specified sets lying in a given range.

Trihornometry: A new chapter in geometry: EDWARD KASNER. A trihorn is defined as the combination of three curves C_1, C_2, C_3 passing through a common point in a common direction. The three horn angles are C_1C_2, C_2C_3,

C_3C_1. The three curves are represented by three points P_1, P_2, P_3 in an auxiliary plane; thus the trihorn is represented by a triangle. The conformal invariants then correspond to the three sides M_{ij}, and the three angles σ_{ij} of the triangle in a new metric where distance is defined by $(x_2-x_1)^2/(y_2-y_1)$. Neither equilateral nor equiangular triangles exist in the new geometry. The sides obey a certain inequality, and the angles a certain equality. If two sides are equal, the opposite angles are never equal; but the sum of the opposite angles is unity. In general any three of the six parts of a triangle (except the three angles) determine the other three, but sometimes two distinct solutions exist. Two triangles with sides respectively equal are not necessarily congruent. A full set of formulas of trihornometry is found. The medians are concurrent, but not the altitudes.

Lower reducibility of functions: MARSTON MORSE. Many of the most important problems of modern analysis and mathematical physics are concerned with the existence of unstable equilibria. Stable equilibria are frequently associated with minima, and the classical variational theory is relatively complete for such cases. For unstable equilibria no adequate general existence theory has been developed. A periodic orbit corresponding to the moon has, for example, never been proved to exist rigorously, and it has been shown that if it does exist it affords no minimum to the Jacobi least action integral and is in that sense unstable. The methods of the author when finally developed would appear adequate for solving such problems. The classical condition of lower semi-continuity which with compactness is adequate for proving the existence of minima is not sufficient for establishing the existence of extremals not affording minima. A new condition of *lower reducibility* has been discovered by the author. Roughly stated, it requires the existence of a deformation of the space neighboring a given point p such that the points at which the functional F exceeds $F(p)$ shall be deformed so as to uniformly decrease F. Such a deformation is shown to exist in all ordinary problems, and various important applications have been made.

Electrokinetics XIX. Interfacial energy and molecular structure of organic compounds V. The electric moment of an Al_2O_3: benzene-nitrobenzene interface: ROSS AIKEN GORTNER and HENRY B. BULL. The electric moment of the double layer at the interface between Al_2O_3 and pure benzene, pure nitrobenzene and mixtures of these liquids was studied by streaming potential techniques. A zero electric moment was for the interface in pure benzene, but a very high value was obtained in pure nitrobenzene. In mixtures containing 10 mol per cent. of nitrobenzene the electric moment was inappreciable and a very low value was obtained for mixtures containing 25 mol per cent. nitrobenzene. Only when the nitrobenzene exceeded 50 mol per cent. were high electric moments obtained. The data are tentatively interpreted as indicating the existence in the mixture of a bimolar compound of benzene-nitrobenzene which prevents the polar character of the nitrobenzene from markedly influencing the electric moment. This hypothesis is supported by the fact that benzene-nitrobenzene forms a eutectic mixture at 51 mol per cent. of nitrobenzene.

Mechanism of the reaction of substitution and Walden inversion: P. A. LEVENE and ALEXANDRE ROTHEN. In order to test recently advanced theories of the mechanism of the reaction of substitution claiming that every substitution by a negative atom or group takes place on the positive end of a dipole, experiments were instituted based on the following considerations. If a single reaction of substitution on an optically active carbon atom should lead to inversion of configuration, then two consecutive reactions of substitution should lead to a substance having the configuration of the starting substance. On the basis of the postulate that the substitution of a $-N_3$ group, a pseudo halogen, proceeds similarly to that of a halogen atom, it was possible to show that in the set of reactions

$$R\text{—}OH \xrightarrow{HI} RI \rightarrow RN_3 \rightarrow RNH_2 \quad \left(R = H\text{—}\overset{\displaystyle R_1}{\underset{\displaystyle R_2}{C}}\text{—}\right),$$

where R_1 and R_2 stand for normal alkyl groups), the configuration of the amine being similar to that of the carbinol, each of the two reactions of substitution is connected with an inversion of configuration. However, when R_1 is an unsaturated radicle, or a phenyl group, C_6H_5, the two consecutive reactions of substitution may lead to a substance having a configuration opposite to that of the starting material, thus showing that only one substitution is accompanied with inversion of configuration, the other proceeding without inversion. Hence, one substitution by a negative ion takes place on the positive, the other on the negative end of the dipole.

The romance of hemoglobin: G. H. WHIPPLE.

On the temperature coefficients of the four transverse magnetic effects in copper: EDWIN H. HALL. The method of experimentation is shown. The investigation, which is not yet ended, indicates that, with a rise of temperature from 25° C. to 85° C., the Hall effect changes less than one per cent., the Ettingshausen effect increases many per cent., the Leduc effect decreases many per cent. and the Nernst effect decreases less, perhaps 7 per cent.

Internuclear distance in oxygen molecules: HAROLD D. BABCOCK. A clearer view of the structure and properties of molecules is the aim of many investigations. The spectroscopic method is particularly useful for molecules consisting of two atoms, among which oxygen affords a favorable case and at the same time has fundamental interest for chemists, physicists and biologists. The theory of molecular spectra has shown that the positions of the spectral lines of a gas may be utilized to determine some of the mechanical properties of the molecule. For example, the distance separating the atoms in the oxygen molecule may be found from measurements of atmospheric oxygen. Recent data give this distance with greatly increased accuracy. Although its value is only about a hundredth of a millionth of a centimeter, variations of the order of a millionth of a millionth of a centimeter are appreciable. The measurements indicate a possible contraction of 2 parts in 10,000 when one of the atoms in the ordinary molecule $O^{16}O^{16}$ is replaced by the rarer heavy oxygen atom of mass 18.

The structure of Langmuir-Blodgett films of stearic acid: L. H. GERMER and K. H. STORKS (introduced by Frank B. Jewett). We have prepared multiple molecular layers of stearic acid upon metal blocks by the method developed by Dr. Katharine Blodgett (*Jour. Amer. Chem. Soc.*, 57: 1007, 1935). Electrons scattered from such built-up surface films produce diffraction patterns consisting of segments of sharp lines lying normal to the specimen surface and arranged along diffuse inclined bands which are parallel and equally spaced. The following conclusions can be drawn from these patterns: (1) The stearic acid is formed into large crystals belonging to the monoclinic system. (2) These are oriented upon the surface with a long crystallographic axis parallel to the long axes of the individual molecules and inclined by 57° to the surface plane, and with two orthogonal axes of lengths 9.4A and 5.0A lying in the surface plane. (3) The crystals possess symmetry characterized by a mirror glide plane normal to the shorter of these axes. This structure is in precise agreement with that of single crystals of stearic acid which we have recently investigated. In these single crystal studies we have discovered different polymorphic modifications. The Langmuir-Blodgett films which we have produced are identical with the modification which we have studied in greatest detail. In our earlier work on these films (*Phys. Rev.*, 50, 676, 1936) we were unable to determine the structure. This work was carried out upon films which had been stripped from the plate upon which they were formed. We now believe that this mechanical treatment produced severe strains and materially changed the molecular arrangement.

The influence of the earth's magnetic field on cosmic ray intensities up to the top of the atmosphere: I. S. BOWEN, R. A. MILLIKAN and H. V. NEHER. Measurement on cosmic-ray intensities such as those made in July, 1936, at San Antonio, Texas, and already published (*Phys. Rev.*, 50: 992–998, 1936), have now been made with equal accuracy in Madras, India. A comparison of the two resulting curves and that earlier obtained in the Fordney-Settle flight makes it possible for the first time to determine experimentally the complete law of absorption of electrons going through the atmosphere in two different ranges of energy, namely, from 2.5×10^8 M E V to 6×10^8 M E V, and from 6×10^8 M E V to 17×10^8 M E V. A law not greatly different from the Bethe-Heitler law as extended by Carlson and Oppenheimer (*Phys. Rev.*, 51: 220, 1937) is found to reproduce reasonably well observed findings.

Cosmic rays and the magnetic moment of the sun: M. S. VALLARTA (introduced by Arthur H. Compton). The indication by Cosyn's stratosphere measurements that the threshold of the latitude effect begins at about 49 degrees for all altitudes may be explained either by (1) assuming that the primary rays have a sharp threshold energy or (2) that particles of smaller energy are prevented from reaching the earth by the action of the magnetic field of the sun. Consequences of the latter hypothesis (suggested originally by Janossy) include diurnal and annual variations in intensity whose agreement with observation is questionable. Any effect due to a possible magnetization of the moon is ruled out because the periodic fluctuations would be greater than is shown by observation.

The structural forces of atomic nuclei: M. A. TUVE, L. R. HAFSTAD and N. P. HEYDENBURG (introduced by W. W. Coblentz). Measurements on the angular scattering of a beam of protons passing through hydrogen gas have resulted in the direct observation and quantitative measurement of attractive forces between two protons when they are brought within nuclear distances of each other, and demonstrate the failure of the Coulomb law of repulsion at very close distances. The measurements show that the proton-proton forces are nearly identical with the proton-neutron and neutron-neutron forces; these three attractive forces are the structural basis for the formation of the nuclei of all the chemical elements. Our observations of proton-scattering in the region 600 to 900 kilovolts gave a quantitative specification of the nuclear forces, as worked out on the basis of the quantum mechanics by Breit, Condon and Present. Observations in the region 200 to 500 kilovolts confirm the results obtained at higher energies and give a very direct demonstration of the fact that the forces between two protons change from repulsion to attraction as they are brought closer together.

Terrestrial effects accompanying several bright chromospheric eruptions: A. G. MCNISH (introduced by F. E. Wright). The recent observation that the intense bright-hydrogen eruptions in the chromosphere on April 8, August 25 and November 6, 1936, were accompanied by simultaneous effects on the earth's magnetism and on radio communication promises a basic advance in the study of the earth's outer atmosphere. Immediately when these bright eruptions were observed with the spectrohelioscope radio signals normally reflected from the *E*-layer and higher layers of the ionosphere ceased to be returned, and a special type of change occurred in the earth's magnetic field. The radio effects indicate that a great increase of ion-density occurred at heights between 60 and 90 km (below the *E*-layer). On the basis of the Stewart-Schuster theory the magnetic effects would be attributable to an increase in electric currents ordinarily flowing in the ionosphere. The beginning of fade-out and magnetic change occurred simultaneously with arrival of visible light from the eruptions. These effects were observed only on the lighted hemisphere of the earth. Thus it is indicated that the ionizing agent was light radiation and not corpuscular radiation. These mutually consistent terrestrial effects may be explained on the assumptions (1) that excitation of gases in the solar atmosphere gave rise to bright-line emission in the ultra-violet region as well as the visible region and (2) that such bright-line emission was much more intense than the ionizing radiation usually coming from the sun. This bright-line emission enhanced ionization, therefore conductivity, below the *E*-layer, where rapid recombination or limitation by absorption prevents high ion-density from normal ultra-violet light. The improved conductivity increased the currents responsible for diurnal variations of the earth's

magnetism and thus caused the unique changes observed. The observed fade-outs of radio signals may be explained by absorption in this region because of high frequency of molecular collisions at these low heights.

Million-volt direct-current x-ray generator for the Huntington Memorial Hospital: J. G. TRUMP and R. J. VAN DE GRAAFF (introduced by Karl T. Compton). This paper describes a 1,000-kv x-ray generator developed by the Massachusetts Institute of Technology and recently installed at the Huntington Memorial Hospital in Boston for the treatment of cancer. The high-voltage source is an electrostatic generator employing six belts, each three feet wide, of commercial belting material and running at about 5,000 feet per minute. The generator operates normally at a steady d–c potential of 1,000-kv with 3 milliamperes on the target, but it can be used over the full range from 400 kv to 1,200 kv. The x-ray tube is continuously evacuated and is of the cascade type, having twenty sections mounted vertically, the potential distribution along the tube being controlled by corona. A lead-shielded steel tube carrying the target at its lower end continues downward from the high-voltage tube well into the treatment room below. This arrangement leaves the treatment room free from all electrical apparatus and high-voltage hazard and permits a wide range of treatment distances. The electron beam is accurately focused on the water-cooled lead target, which is at ground potential, and the radiation transmitted in the downward direction is utilized in treatment. The generator produces an intensity of 100 roentgens a minute at 80 centimeters' distance with 4 millimeters' lead filtration. It is compact, rugged and simple in operation.

Unique crystallization phenomena of protocatechuic acid; motion pictures of automotive crystals: R. W. WOOD. Perhaps the most remarkable phenomenon of crystallization: discovered in 1888 by Otto Lehman and apparently completely lost sight of. The substance crystallizes in four different modifications according to the conditions. The one of especial interest develops branched rods like the claws of a crustacean. The joints straighten out by a progressive motion of the sharp angle of bend (twin-plane), which in one or two seconds runs along the crystal to the tip, the bent rod becoming straight. Thicker rods frequently grow a cluster of spreading claws at the end, which suddenly close together and unite into a single crystal which forms a prolongation of the rod. Large clusters of these crystals form resembling the tentacles of a barnacle, and there is constant movement as the bent rods straighten out and the finger-like tips come together and fuse. Under other conditions long, straight needles form, or rhombs resembling Iceland spar.

The measurement of light signals on moving bodies by transported rods and clocks: HERBERT E. IVES. The equations are developed for describing the times of transit, distances traversed and velocities of light signals on moving bodies, with no restriction on the speeds with which the measuring rods and clocks are moved. The study is based on the assumptions of Fitzgerald, Lorentz and Larmor: (1) That moving rods are contracted in the direction of motion in the ratio

$$\sqrt{1-\frac{v^2}{c^2}} : 1$$

where v is the velocity of the rod, and c the velocity of light; (2) that the frequencies of moving clocks are reduced in the ratio

$$\sqrt{1-\frac{v^2}{c^2}} : 1.$$

The expressions derived are put in terms of the relative velocities of the rods, clocks and bodies concerned, as observed. These expressions are invariant with v, as long as identical measuring procedures are used, *i.e.,* the rods and clocks are moved with the same observed velocities. The velocity of light on a moving body, so measured, is not the constant c, but the product of c and a function of the velocities of transport of the rods and clocks. This function approaches unity as the rod and clock velocities become small. The time of transit of a light signal to a distant mirror on a moving body, so measured, is not half the total to and fro time, but approaches this as rod and clock velocities become small. The entire set of formulae approximate the Lorentz transformations as the observed rod and clock velocities become small with respect to the velocity of light.

Differences in mutability in various wild-type lines of Drosophila melanogaster: M. DEMEREC (introduced by A. F. Blakeslee). Mutability of the following wild-type lines was studied by determining the frequency of the occurrence of spontaneous X-chromosome lethals: Florida-inbred; Wooster, Ohio; Formosa, Japan; Oregon-R; Swedish-b; California-C; Huntsville, Texas; Urbana, Ill.; Canton, Ohio; Amherst, Mass.; Woodbury, N. J.; Tuscaloosa, Ala.; Lausanne; Seto, Japan; and Kyoto, Japan. Of these, the first three mentioned had a higher rate of mutability than the other lines. The mutability of the Florida line was 1.09 per cent.; of the Wooster, Ohio, 0.63 per cent.; and of the Formosa line 0.39 per cent., while the average rate for the other 13 lines was only 0.1 per cent. The responsibility for the high mutability rate of the Florida stock was traced to a recessive factor located in the second chromosome. Evidence suggests that this gene is specific in its action: that it increases the mutability rate only in early embryonic development and only in germinal tissues. Such genetic factors influencing the stability of a genom play an important rôle in increasing the variability of the line where present, and thus they may have important bearing on the evolutionary processes within a species.

Bud sports in Datura due to elimination of specific chromosomes: ALBERT F. BLAKESLEE, AMOS G. AVERY and A. DOROTHY BERGNER. In Datura clear-cut cases of bud sports due to mutations in single genes have not been identified. Bud sports due to chromosomal mutations, however, have been relatively common. Those most frequent involve doubling of the whole chromosomal complement to produce a diploid branch on a haploid or a tetraploid branch on a diploid. Elimination of a single chromosome or a chromosome fragment is a not uncommon cause of bud sports. A tabulation of the records for the last 15 years since chromosomal eliminations were first noted shows that such chromosomal deficiencies are con-

fined almost entirely to those which involve the 1 · 2 or the 17 · 18 chromosome. The condition is most striking in respect to the 1 · 2 chromosome. Nearly every season at least a single case is found in which the 1 · 2 chromosome is eliminated to form a 2n − 1 · 2 branch. The · 1 half of this chromosome seems to be chiefly responsible for the chromosomal elimination. In several cases a 2n + 1 · 18 plant has produced a 2n branch by the elimination of the 1 · 18 chromosome, while no 2n + 2 · 17 plants have shown sectorial deficiencies. The 1 · 1 chromosome in the secondary 2n + 1 · 1 type is so frequently eliminated to produce 2n branches that we have found it difficult to keep this type growing without its reverting to normal diploid. The complementary 2n + 2 · 2 secondary, of which larger numbers have been under observation, has only once been observed to have eliminated its 2 · 2 chromosome. It is concluded that the rate of chromosomal elimination in the formation of bud sports is different for different chromosomes and that, in the case of the 1 · 2 chromosome, it is the · 1 half which most strongly stimulates the elimination.

A treatment of hosts having opposite effects on leukemic cells of high and low virulence: E. C. MACDOWELL, J. S. POTTER and M. J. TAYLOR (introduced by A. F. Blakeslee). A single treatment of susceptible hosts with embryo tissue of specified genetic constitution will induce resistance to implanted leukemic cells that have become highly virulent in the course of long-continued transfer from mouse to mouse. These hosts are under two months old; if mice of this strain are not treated in any way, nine out of ten will develop leukemic cells spontaneously in later life. However, the identical embryo-treatment, continued at monthly intervals throughout life, completely fails to reduce the incidence of spontaneous leukemia: indeed, the embryo-treatment actually hastens the time of death from leukemia. Failure to induce resistance against spontaneous cancer has led to the general belief that it is not possible to immunize an animal against its own cells. But is this result due to the unique relationship between malignant cells and the animal in which they originate or to the properties of the "spontaneous" cells? This question is answered by breaking the correlation between the animal and its own leukemic cells by means of a single transfer to other hosts. Leukemic cells from a spontaneous case were inoculated into equal numbers of embryo-treated and untreated hosts. Leukemic cells from a long series of transfers (653) were used in the controls. All the controls without embryo-treatment (6) died in 6 days; with embryo-treatment, nine out of ten are alive at 3 months. The "spontaneous" cells in untreated hosts killed in 41 days (average); in embryo-treated hosts, in 32 days. Twenty-one days after inoculation with "spontaneous" cells, 16 of the 20 embryo-treated mice showed large spleens, against 4 out of the 20 mice without embryo-treatment; nine of the embryo-treated mice died before the first of the mice without treatment. Compared with long-transferred cells in untreated hosts, the "spontaneous" cells required nearly seven times as long to kill, although given in doses approximately 80 times as large. The condition in hosts induced by treatment with embryo tissue may at the same time resist the growth of highly virulent, long-transferred cells and facilitate the growth of leukemic cells taken directly from a spontaneous case. The failure of embryo treatment to resist the spontaneous occurrence of leukemia is related to the properties of "spontaneous" cells rather than to the unique relationship between an animal and its own cells.

A developmental analysis of the relation between cell size and fruit size in the Cucurbitaceae: EDMUND W. SINNOTT. The growth of the fruit from ovary primordium to maturity, in this family, is due to an increase in both the number and the size of its constituent cells. Cell multiplication occurs primarily in the early stages, and in tissues other than the epidermis it is finished by anthesis or shortly afterward. During this time cells increase somewhat in size. The bulk of the increase, however (which is often more than 1,000 fold), occurs after the last division and is responsible for most of the increase in fruit size between flowering and maturity. Different tissues behave differently, the inner ones attaining a greater cell size than those toward the periphery. The developmental history also differs between genera and to a less extent between races of the same species. In *Lagenaria* all pericarp tissues (except the epidermis) stop dividing at about the same cell size, but this is reached first in the inner tissues and later in the outer ones. In *Cucurbita*, however, division stops at about the same time in all, and the relative cell-size differences attained at that time persist to maturity. The point at which cell division ceases, and the extent of cell enlargement, differ markedly in fruits which grow to different sizes. Both cell number and cell size are therefore important factors in determining differences in mature fruit size. Any consideration of the relation between cell size and organ size must evidently take into account these differences between tissues and between genetically diverse races.

Cerebral processes during sleep as studied by human brain potentials: E. NEWTON HARVEY, ALFRED L. LOOMIS and GARRET A. HOBART, III. A long series of records has demonstrated that the electrical potentials of the brain recorded from similar positions on the scalp of normal persons differ greatly in pattern. Two types of individuals with every possible intergrade can be distinguished; at one extreme the type with almost continuous pure alpha (ten a second) rhythm; at the other the type with practically no alpha rhythm but with marked beta (30 to 40 per second) potentials. The potential patterns during sleep are so characteristic that they may be used as a criterion of states or depth of sleep. In a person showing marked alpha rhythm the changes are: (1) More and more marked interruption of the alpha rhythm, (2) complete disappearance of the alpha activity, (3) large random potentials and (4) random potentials plus short bursts of 14 per second rhythm ("spindles"). Disturbance, such as a low sound, during (1) results in the appearance of almost continuous alpha rhythm. Disturbance during (2) and (3) results in bursts of alpha rhythm lasting a few seconds. Disturbance during (4) does not change the record. Return of alpha rhythm is sudden on awakening. The effect was

clearly apparent in one subject who unintentionally fell asleep while trying to carry out a set of instructions, namely, open the eyes during a tone and light signal, and then close them again. The tone and light lasted 5 seconds and was repeated automatically every 30 seconds. The psychological background must be kept in mind in this case, namely, a very sleepy yet conscientious person trying to obey instructions. The record showed that when the eyes were opened the alpha rhythm stopped, and when closed the alpha rhythm continued. This is the normal response of a person awake. The alpha rhythm then disappeared for periods of 20 to 30 seconds and reappeared again even when the light was on. This corresponds to the borderland of sleep when a person can sometimes signal that he is awake and sometimes not. It was quickly followed by a complete change in the record in that the alpha rhythm was replaced by random potentials which were interrupted by a burst of alpha potentials beginning .75 second after the tone appeared and lasting 2 to 3 seconds, and another similar burst after the tone stopped. This continued for five minutes and then only random potentials occurred with no alpha rhythm at the beginning or end of tone signal. Another state of sleep had been reached. Soon the 14 a second "spindles" appeared, indicating deep sleep. Shortly afterward a door was slammed, when the continuous alpha rhythm appeared and the subject awoke. During the third state of sleep when the tone signal gave rise to a short burst of alpha rhythm the subject anticipated the tone by 2.5 seconds for three successive half-minute periods. Evidently a subconscious cyclic process of some sort is going on in the brain which is no doubt the basis of our perception of time intervals. Persons with no alpha rhythm show 14 a second "spindles," but otherwise the record looks much the same whether asleep or awake. Our experience with many subjects has trained us to distinguish states of sleep with ease in the type whose alpha rhythm is marked.

Elimination of radium impurities from the blood stream: ROBLEY D. EVANS (introduced by K. T. Compton). In cases of chronic radium poisoning several micrograms of radium element are stored in the bones of the body. The usual metabolic exchange of calcium and other elements between the bones and the blood stream includes the removal to the blood stream of a small fraction of the radium stored in the bones. By increasing some ten thousand fold the sensitivity of the detection apparatus previously used in our studies of the radium eliminated daily in the body wastes, we are able to determine the radium content of 5 cc specimens of blood. Combination of these two experimental results yields information on the efficiency of the eliminative organs in removing heavy element impurities from the blood stream. In human beings the daily elimination, in the case of radium, is the order of ten times the total amount of radium impurity contained in the blood stream at any one time. With appropriate changes in radioactive detection technique, these same principles may be employed in studies of the rate of transfer from the blood stream to the intestine of a number of chemical elements, through the use of their artificially radioactive isotopes as chemical indicators.

Changes in respiratory pattern associated with different types of vocalization: WALTER R. MILES. Human subjects when connected to a closed-circuit respiration spirometer system by means of a helmet fitted with a thin rubber collar which lightly but with air-tight closure encircles the neck can read aloud, talk, sing or engage in other types of vocalization without experiencing any uncomfortable restraint from the apparatus. Graphic tracings of respiration curves recorded under these conditions show characteristic differences according to the type of vocalization. For example, in oral reading the respiration rate is about half as fast as in silent resting (reclining posture in both); the amplitude is approximately twice as deep, the inspiration phase is quicker, and shallow "supplementary" breaths are interspersed at irregular intervals between the deeper inspirations. There is frequently a very conspicuous change in the level of breathing accompanying vocalization. The average expiration level, known to be usually quite stable, falls in singing below that for normal resting. In contrast, oral reading, conversation and, still more strikingly, impromptu speaking, all tend to show a marked increase in the reserve air amounting frequently to as much or more than the value of the tidal air in the same person. After vocalization has ended there is usually a prompt readjustment in the reserve-air volume to the former silent resting level. Psychological factors observed during the study, such as degree of tension and the manner of adjustment, appear to correlate with some of the respiratory changes observed.

Individual differences in communities: EDWARD L. THORNDIKE. Measurements were obtained of 117 cities in over a hundred characteristics, including such as infant death-rate, salaries for teachers, percentage of families paying less than $10 a month rent, percentage of houses with gas, electricity and telephone, and park acreage per person. From the city's scores in twenty-three characteristics where a high score is admittedly an indication of the goodness of life for good people, a score (call it G. G.) for general "goodness" was computed. Cities differ widely in G. G. Their differences in general "goodness" were studied in relation to per capita taxable wealth, to per capita private income and to personal qualities and behavior of the population, such, for example, as are evidenced by owning homes, having children graduate from high school, containing many physicians, nurses and teachers and few male domestic servants. It was found that only 33 per cent. of the variation of cities in G. G. was accounted for by wealth and income, and 60 per cent. by the personal qualities and behavior of its population.

Observations and measurements on the members of the National Academy of Sciences: ALEŠ HRDLIČKA. (Read by title.)

Biographical Memoir of George Davidson: CHARLES B. DAVENPORT. (Read by title.)

Biographical Memoir of Augustus Trowbridge: KARL T. COMPTON. (Read by title.)

Biographical Memoir of George Sumner Huntington: ALEŠ HRDLIČKA. (Read by title.)

Biographical Memoir of Charles Edward St. John: WALTER S. ADAMS. (Read by title.)

Biographical Memoir of Carl H. Eigenmann: LEONHARD STEJNEGER. (Read by title.)

Biographical Memoir of Arthur Gordon Webster: JOSEPH S. AMES. (Read by title.)

OBITUARY

WILLIAM TEMPLE HORNADAY

OVER a span of sixty-six years—or from that day in 1871, when, as a boy of seventeen, he commenced the study of the art of taxidermy at the Iowa State College until he wrote his last article on wild life conservation within a few weeks of his death on March 6—Dr. Hornaday was an ardent and creative force in the field of zoology. The term zoology is used in its broadest sense, since even this brief outline of his life will indicate the many and varied accomplishments which stand as an abiding monument to his creative nature, well-informed mind and impelling sympathy and interest in animal life.

The facilities at the State College soon proved too limited for him, as by this time he was committed to zoology as a life-career, so he summarily left college without graduating and came East to study at Ward's Natural Science Establishment in Rochester, N. Y. Here he rapidly perfected himself in all the branches of taxidermy, and in 1874, when only twenty years of age, he was sent out on his first scientific expedition and within six years his field work had taken him to Florida, Cuba and the West Indies, then to South America, and finally to the Orient—India, Ceylon, the Malay Peninsula and Borneo—from whence in 1880 he returned to the United States with a zoological museum collection said to have been the richest and most varied ever made in the field by one man up to that time.

In that year he formed the National Society for Taxidermists and two years later was called to the position of chief taxidermist of the United States National Museum of Washington. He pursued his work there until 1888, and during this time was requested by the government to conduct an expedition to Montana to obtain specimens of the fast vanishing American bison for mounting and exhibition in the museum. He completed this work with distinct originality, for the method he created in mounting and arranging this group marked the beginning of the now popular museum habitat groups.

During this same period he conceived the idea of the establishment of a National Zoological Park in the nation's capital and brought his plans to reality. Congress appropriated the sum of $292,000 to carry out the project, and Dr. Hornaday was made the superintendent of the new park, which was placed under the control of the Smithsonian Institution. As a consequence of questions of policies which arose with which Dr. Hornaday was not in sympathy, he resigned and at the same time gave up his position in the United States National Museum.

For several years thereafter Dr. Hornaday lived in Buffalo, N. Y., but in 1895, upon the formation of the New York Zoological Society, he was called as director of the Zoological Park—for which plans were then being formulated. No better man could have been selected, for, in the development and carrying out of these plans, which were to place the New York Zoological Park in a premier position among such institutions anywhere in the world, Dr. Hornaday played an energetic and leading part, and it was because of his expert knowledge and creative ability in this position that he soon became known both throughout this country and abroad.

In addition to his primary interest in living animals he realized the permanent advantage which would result from the establishment of a national collection of heads and horns. He consequently formulated plans for this project and obtained enthusiastic endorsement from the officers of the society and a number of sportsmen who were the owners of trophies. Thus were laid the foundations for a national collection which eventually grew to such proportions that a building, the only one of its kind, was erected in the Zoological Park especially to house it, dedicated to the vanishing big game of the world.

His courage and independence of thought were outstanding characteristics, as well as his ability to do more than one thing well at the same time. It was during the early years of his position in New York, even when his duties as director of the park were most onerous, that he—enthusiastically supported by some of the officers of the society, such as the late Professor Henry Fairfield Osborn, Mr. Madison Grant and others—began his active work for the conservation of wild life, which engaged his vital interest up to the very last days of his life. He fought successfully for such measures as the Bayne Law to prohibit the selling of native game; the insertion into the tariff law of the provision against the importation of wild birds' plumage for millinery purposes; the promotion of the international migratory bird treaty between the United States and Canada; the Snow Creek Game pre-